This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

92 d

STANF
LIBRAR

A

DISSERTATION

UPON THE

GIN OF MINERAL COAL,

Y CHARLES WHITTLESEY,
(Late of the Geological Corps of Ohio.

STANFORD LIBRARY

CLEVELAND:
RINTED BY M. C. YOUNGLOVE.
1845.

553.2

214913

STANFORD LIBRARY

Introductory Remarks.

The following argument against an opinion almost universally received by geologists was composed for publication in the *American Journal of Science* and was forwarded to the editor for that purpose in 1842. Professor Silliman respectfully declined to insert it contradicting as it does his own opinions.

While traversing the State of Ohio, some years since, I found that our citizens took a lively interest in whatever relates to geology and the earth, and read and reflected upon what is published concerning them. Numbers of intelligent men disputed with me the doctrine of the books, that bituminous coal is of vegetable origin. A theory which met with such general disbelief, even though among men whose pretensions to science were nothing, must at least possess something unnatural. Geology itself is little more than an abstract of the *observations* of individuals; a collection of facts, by the labor of thousands. Every person has to do with the materials of the Surface of the earth, and almost every observing man examines these substances with scrutiny and naturally reflects upon the changes they have undergone.—No subject of a scientific kind, is more popular or better adapted to the circumstances and capacity of the mass. When a theory in such a science, therefore, meets with almost universal discredit, this is a reason for *re-examination* by men of science; although it may not of itself go far to overturn the doctrine.

It is certainly better, if it is desirable to distribute "learning among men," that the deductions of books should contradict the popular belief and common observation as little as possible. To reconcile discrepancies between what is called common sense, and science, rather than strive to widen the distance between them, by advancing what is mysterious and incomprehensible.

With these views I began a review of the doctrine of the books: that coal is of vegetable and not mineral origin; and my researches and observations have converted me to the popular side, in opposition to the authorities. Some of my reasons will be found in this paper.

I am aware that to professed geologists my presentation of the subject may not be satisfactory. Like myself heretofore, they are now committed to the vegetable theory, and have a bias in its favor.—Many of the professors in geology, are in advanced life and commenced their studies while the science was in its infancy, and when the authority of books was almost supreme. Its ablest authors have reaffirmed the doctrine in their books with new arguments and facts. Dr. Sangrado considered this a sufficient reason for maintaining his old opinions.

Perhaps some of the fathers of the science may here find enough to induce a reexamination of the old doctrine; and with them many of the younger geologists.

If this is done in a spirit of candid enquiry, untrammelled by habit and ancient authority, and my ideas should still be regarded as erroneous, the old theory will thereby receive strength and its friends will occupy their position with new evidences of its correctness.

Structure of the Earth—Its Law of Harmony.

The outer masses or crust of the earth are composed principally of earths, alkalies and oxides, sometimes in combination with acids or simple substances, such as sulphur and phosphorus, and sometimes not. We have these facts by observation. They are not deductions of science but matters of plain every day experience. The learned may know most of the properties and chemical composition of the globe on which we live, but all men have knowledge enough to observe a palpable difference between it and the animals and trees which exist upon it. They call the earth a *mineral* "kingdom" to distinguish it from the animal, or vegetable kingdoms. Geologists make use of the same terms. It is not singular, therefore, that the mass of mankind are taken by surprise, when they are told that in this grand division of the universe called *mineral*, there is *one exception*; and that an important portion of the Secondary rocks are *vegetable* rocks. Is not this apparently an arbitrary violation of that conspicuous uniformity, law and order which pervade the universe? Would it not be safer, more philosophical, and even more reverent towards the creator himself to forego the adoption of a theory so contradictory to the spirit and harmony of his works? Is it not better to be without a theory than to adopt one which is absurd, without the clearest proof? The doctrine we are combatting was one of the earliest speculations of geologists; while as yet the science was enveloped in the darkness and errors of its first dawn. Mr. Lyell says of the geological fathers that they "indulged in many visionary theories." If the bias of their readers has been to sustain their theories, without careful examination as original questions, the authority of the later works taking the same side is thereby much weakened. Does not the exact transmission of language and thoughts from the early writers down through all the subsequent works to our time, prove the supposition of such a bias?

Let us suppose the question here started for the first time. That there had hitherto been no theory and consequently no prejudice—that men, content with an observation of the rocks, their order, composition and economical value, had not speculated so much upon their origin.

On the surface they find; first the diluvion, composed of loose fragments of rocks, constituting gravel, clays, marls and sand, confessedly of a *mineral* nature.

Descending in the natural order, next come the tertiary formations, made up of stratified beds of clay, limestone and other rocks. Still farther down in the body of the earth, we strike the cretaceous group, with lime as a base—then the green sand, composed of earths and alkalies—the oolitic system of alumine and lime—the red sandstone, lime and silex. Nineteen-twentieths of the coal formation itself, is shale, sandstone or limestone. It rests upon the conglomerate, all silex—that again upon 1500 to 2500 feet of aluminous, calcareous, and silicious rocks, which, whatever may be their character or origin, we attribute to one method, and call them all by the name of mineral substances. At the bottom of the Cambrian system, a different method of formation is observed; no more organic remains—no farther stratification, or order of super-position; but the same ingredients are still present, lime silex, alumine and oxides of metals, even metals themselves, and they are here as elsewhere denominated minerals.—In fact the younger rocks are considered as composed of the materials of the older merely changed in position, and in form. The agent employed in this work of change, is thought to be water. It is supposed to have possessed by means of heat, or acids, or some corrosive mixtures, an extraordinary solvent power, and strong chemical force, sufficient to effect the dissolution of the ancient or primitive rocks.—Yet it is denied that this menstruum could liquify bitumen, and therefore we must look for some cause for its production on the spot where it is found. That not being soluble in water, it could not have been taken up with the materials of the secondary rocks; and being specifically lighter, could not have been deposited by that fluid. It is moreover advanced as a geological truth that bitumen did not exist until the era of the secondary rocks, because none of it is found in the primary.—If it is settled by observation, that the primitive rocks do not contain bitumen, it would readily be accounted for by the igneous origin of that great portion of the earth's crust, during which the heat would consume or drive it away. The heaviest masses of bitumen are in Trinidad, Palestine and the Burman Empire. Their relation or contiguity to primitive rocks, does not seem to have been thoroughly understood, or even examined; neither is there any evidence to connect these immense beds of bitumen with vegetable matter.

Cases are known of its presence in the transition series, some of which will be given hereafter. If it is, as contended, a kind of artificial compound, formed from vegetable matter, in the laboratory of nature, among the secondary rocks, there would not seem to be any necessity for its existence in the transition, the bitumen of these rocks not having been provided in a form, or in quality for economical purposes. The fact of its absence from the primitive rocks, (if it shall prove to be a fact) may be advantageously compared, with the same state of things, in regard to gypsum, salt and other minerals of the highest value to man, which these rocks do not furnish. In truth, the argument drawn from this source is not strictly in keeping with geological principles, for the most striking peculiarity of the system, next to its stratification, is the fact, that almost every mineral has its peculiar rock, and it is a common expression to denominate a formation the "lead bearing," "copper bearing," or "tin bearing" rock. It does not follow, therefore, that coal should have been found in the primitive rocks, or that its absence would be regarded as affecting the question of the manner of its creation, but only the order as to time.

From the granite upwards, where we find a stratified rock, it bears evidence of the action of water. By this agent as now universally conceded, the materials were disposed in planes or strata. Wide seas rolled over the earth where the dry land now appears. Approaching the era of the coal formation, the conglomerate rock is deposited, as a basis to the series. Sometimes a coal stratum itself, rests directly upon the pebble rock, but usually 50 or 100 feet of shales, sandstone, iron stone, limestone or fire clay intervene. All these are regarded as aqueous deposites at the bottom of the ancient sea. Ascending, through the entire thickness of the coal series, it is not unusual to pass 20 and sometimes 30 distinct beds of coal, separated by the rocks just above named. Unless then, the coal is a product of marine plants, there must have been during the deposition of the coal formations as many radical changes in the condition of the surface of the earth as there are beds of coal. Most of the fossils of that formation, are *land plants*, of large size, and required, if not dry land for their roots, an atmosphere for their leaves and branches.—The shales, limestones, &c., could only have been deposited beneath the surface of water, and they now occupy the same area as the coal. Upon each square rod of ground, occupied by these 20 beds of coal, there must have been 20 recedings of the universal sea, 20 returns, and 20 periods of vegetable production, on the surface of the earth.

And this, long before the globe was fitted for the permanent occupation of the vegetables intended for its final state. For at that epoch, the geological structure of our planet was not complete. It lacked a part of the secondary, and all of the tertiary and diluvial deposites, since then piled upon the coal. Now, although it is sometimes advanced, that large masses of rock formations, were the result of gradual concretions, by marine animals, like the coral polypii; and that these furnish an analogous case, the distinction is in fact too great to admit of analogy. Whether the animalculæ originate the substance of the rock, or merely extract the mineral contents thereof from the water, thus *assisting deposition*; there is nothing *unnatural* in the process. Many are marine, and calculated to flourish beneath the waters where they are found. If, instead of mollusca and crustacea, we found the fossil remains of birds and quadrupeds, and attributed the rock formation to their agency, the cases would be parallel, and equally strange.

Statement of the Question.

My proposition is simply this—*the coal and the coal bearing rocks have a common origin.* If, therefore, we call the shales, sandstones, &c. of that formation, *mineral in their origin*, and deposited from water, then the coal must be called mineral also; and an aqueous deposite. If the sandstones, shales and iron beds, containing myriads of vegetable fossils, are misnamed, and are in fact of vegetable parentage, then the same term is applicable to the beds of coal contained within them.

The question itself would be regarded as a matter of idle speculation, if it had not assumed a prominent place in geological books now read throughout the world.

Geological and Lithological Character of Coal.

To begin the comparison: the coal is *stratified* like the other rocks. Its external stratification is in fact more perfect than any other rock of the coal series, except the limestone. Its superior and inferior surfaces are more regular and parallel than either the shale or sandstone. In proportion to their thickness, the coal strata extend over greater spaces, without being cut off or lost, than any other. In the roof of a mine, the rock is seen to change in character very often. A bed of shale, in contact with the coal, is displaced by a deposite of sandstone; and these thin out and thicken up rapidly, while the coal holds one uniform thickness and quality. The iron strata are more limited in extent than the coal. The main coal beds appear (when not disrupted by force) to extend throughout the basin to which they belong—in America many hundred miles across. Of internal stratification or lamination, the slates and shales are considered as offering the most perfect specimens; and as proving, most conclusively, the fact of sedimentary disposition. The lines or planes of deposite are so distinct, as not to admit of a moment's hesitation. The stratum of shale, in which this conclusive record of aqueous action is found, rests upon another; which is bituminous coal, and that upon a third, perhaps as well laminated as the first. In the case which often occurs, where the intermediate bed is blue limestone, instead of coal, the marks of internal stratification are few, the fracture being as easy in a vertical, as in a horizontal direction. Yet without these additional proofs, there is no hesitation in ascribing the blue limestone to a mineral and watery origin.

The bituminous coal, is a real slate. It generally breaks readily at the vertical joints into rectangular blocks. In a horizontal direction, or parallel to the surface of the bed, it *splits into thin lamina*, from the thickness of paper to that of a table knife.

By examining the edge of a block of coal, these partings or leaves are made apparent to the eye, by the changes of color from brown to jet black. The sulphuret of iron, and plates of clay, are sometimes interlaminated. The difference in color, at the edge of the specimen, arises from a difference in the purity of the lamina. When carefully burned, the brown, or lighter streaks, will be found to have the most ashes, or earthy residue. This is a general rule. If the coal is quite pure, the minute planes are less apparent, but as it embraces more earthy matter, it becomes less valuable, and passes through all grades into bituminous shale, which burns slowly, and retains the slaty structure after the fire has passed through.

In the mines at New Castle, Ohio, the iron pyrites take a stratified form, extending many hundred feet, of a thickness not exceeding an inch. A layer of shale, about 3 inches thick, occupies the middle of a bed in Lawrence county, Ohio, for many miles. The top of the stratum, is different, in all coal beds, from the bottom, being more impure, and consequently more slaty. In fact, cut a section down through the superior shale, into the coal itself, and examine the evidences of lamination in both, there will be found no material difference, in this feature, on passing from one to the other.

It is probably a waste of time to multiply proofs of the *stratification of coal*, both internal and external.

Prof. Hitchcock (in his geology, p. 54) makes the following deductions, from the fact of stratification—"All stratified rocks, appear to have been deposited from water. Proof—The manner in which the ingredients are arranged in parallel strata, and lamina, is precisely like that of sub-aqueous deposites. By no other agent that we know of, is the stratified and schistose arrangement of rocks produced."

Bitumen, and its Presence in Rocks.

Bitumen is not soluble in water; and therefore it is averred, and with much apparent force, that it *could not* have been in suspension by water. And more: it is specifically lighter, and *could not* have been deposited by that fluid. If, however, it can be shown, that both these things *have taken place*, the abstract difficulty must give place to the fact. And whether a theory, may or may not be found, to do away with the supposed obstacle, will not be a matter of much importance, after the obstacle itself has been forced out of the way.

Bitumen, whether soluble or not, exudes from the earth in thousands of instances, in a liquid state, and in connection with water. Now, for the purposes of geological union, or even of chemical action, the great object is gained, when the substances are in a state of liquifaction; for they are thus enabled to obey their affinities, and move towards the centre of attraction.

In Ohio, the rocks *below the coal* are bituminous. An old salt well, in Liverpool, Medina county, sent off at first many barrels of petrolum; and this boring is in the slate formation, beneath the fine grained sandstone. The well is in a valley, probably 300 feet below the conglomerate, and perhaps 100 feet above Lake Erie. The bitumen began to flow at 90 feet from the surface. Dr. Locke (Geol. Rep. Ohio, 1839, p. 271) says: "I have noticed that the rocks *above the blue limestone* and below the sandstone, are bituminous, and occasionally have cavities filled with petroleum, like thick brown oil." From the blue limestone (a lower member of the great limestone formation of Ohio) the upward section is as follows—

Cliff Limestone and Marls - - -	272 feet
Black Shale or Slate - - - -	251 "
Fine grained (or Waverly) Sandstone -	343 "
Conglomerate——	

The Black Shale is sometimes sufficiently bituminous to burn, with a bright flame. It doubtless contains bitumen and carbonaceous matter enough in the 250 feet to constitute, if collected, a heavy bed of coal. According to the Geological Report of Michigan (1838, p. 8) there are cavities in the limestone of that peninsula (called the mountain limestone) which are filled with bitumen. The geological position of the rocks of Ohio below the conglomerate, has been the subject of much discussion. Mr. Hall, of the New York Survey, is confident that the fine grained sandstone should be classed in the Devonian System—Am. Journal for Jan. 1842. If this is a correct classification we have 500 feet of rocks, older than the old red Sandstone, that are charged with Bitumen. That of the Shale is sometimes distributed throughout the mass in a solid form. In other places it is liquid, and flows from the earth in connection with inflammable gas.—I have a specimen of solid bitumen from a septaria, or calcareous spheroid, imbedded in this formation; which, when taken out, weighed several pounds.

The fine grained sandstone itself encloses bitumen, disseminated throughout its texture.

We have then established beyond dispute, the existence of this substance, through a wide range of *sedimentary and stratified rocks destitute of vegetable remains.* If therefore the presence of vegetable reliquiea, in the coal series, is proof that the bitumen of that formation is derived from them, their absence in the black shale and limestone, is evidence to sustain the assertion, that in the latter rocks, it is not drawn from such a source. Even in the fine grained sandstone, vegetable fossils are most rare. Should the friends of the vegetable theory, abandon it as to the rocks below the fine grained sandstone, supposed to be the equivalent of the Portage and Gardeau rocks of New York, the question will be confined to the animal and the mineral kingdom.

For the animal doctrine, the evidence would be found as strong throughout the upper limestone, as it is for the vegetable in the coal. In order to escape a natural inference, that a mineral substance had a mineral origin, a resort is had to two methods of originating the same thing; one chemical, and the other animal. But even then, how is the non-fossiliferous shale to be provided? By transportation from other rocks? How transported except by the agency of water? And how disseminated, through the body of a rock, if not in solution, or mechanical suspension; and intimately mingled with the materials composing that rock, at the time of its deposition.

So we have a substance, in existence at the Silurian epoch, scattered widely through that system, entering into the structure of its rocks, stratified with it, before the age of land vegetation, and probably prior to the existence of dry land, *ascribed to a vegetable source.*

These instances are selected from the older rocks, beneath the coal; because in regard to the bituminous shale, of the coal series it might be claimed that the bitumen, being supplied in immense quantities, might be included in the sedimentary rocks mechanically, and by the force of pressure, driven, or injected into the pores of the rock. This, indeed, would have little to do with its origin; but might obviate, in a small degree, the necessity of solution in water. But it will never be contended, that it could be forced downward through 800 feet of compact rock, of a much earlier date, though such a supposition would be more rational than that of a vegetable supply. And in that case, there must have been a complete diffusion of the inflammable principle, in an aqueous medium—a thing which is held to be impossible.—The coal itself, is not therefore the only magazine from which liquid and solid bitumen may be drawn. Having shown that it exists, in a form and place where there can be no evidence found, connecting it with the vegetable kingdom, it follows, that if it is true, that some coal or bitumen has had such an origin, it is not true, that *all* of it originated in that manner.

Carbon, Oxygen, &c., Exist in Rocks.

I use the terms *coal* and *bitumen* together; for it is in regard to the *bituminous principle only*, that the difficulty occurs; the carbon of coal being confessedly attributable to a mineral origin. The same is true of sulphur, oxygen, nitrogen and hydrogen, constituting, with the metals the mass of the globe. It is beginning to be a favorite theory, that the animalcule of silicious sedimentary rocks, and the marine animals of the old lime rock, had a share in furnishing the materials of those rocks. By this is probably meant, not that the animals created new substances, but extracted them from the waters, by which they were surrounded. Consequently, these materials had a previous existence, in solution or combination, now merely modified in form by the power of animal secretion.

They are therefore, in reality, of another origin, that is mineral; and if, for the sake of analogy, the geologist resorts to the theory of animal formation, as favoring the idea of a vegetable one, it will go but a small distance towards such a result. If it is supposed that the decaying bodies of the fossil races furnished the mass of the great lime rock, for instance, it will be replied that the analysis of those bodies will not give the material which remains, the quantity of earthy result being in comparison nothing; the preservation of form impossible; and the whole doctrine of aqueous deposition is overthrown.

The silicious and calcareous *coverings* of marine animals, doubtless went to increase the bulk of the deposite which entombed them; but these shields, in general, correspond in composition, with the ingredients suspended in the surrounding medium, and are ***but a deposite*** from it.

Formation of Coal Described.

The words of one author do not differ materially from those of another, when describing the origin of coal; and the distribution of the vegetable masses which are supposed to give rise to it. I take those of Prof. Hitchcock, p. 262. "While the earth was in a state unfit for the animals and plants now existing upon it, it was covered with a gigantic vegetation, whose relics became entombed, and were gradually converted into those beds of coal which are now in the course of disinterment."

The evidence of the existence of tropical plants at that period, with a gorgeous foliage, comparing, in profusion and beauty, with the luxuriant palms of the equatorial regions, is too plain to leave a doubt on the mind. The roofs of our mines are ceiled over with fac similes of that ancient vegetation, preserved in the perfection and freshness of life. These, however, are distributed mainly throughout the strata *above and below the coal*; and less frequently in that stratum itself.—There is, in bituminous coal, and in anthracite also, an appearance, between the layers or lamina, resembling in some degree the compressed fragments of wood or woody splinters. The substance which remains is pure charcoal, not bitumenised, and forms only a small portion of the mass. It is light and chaffy and bears no other resemblance to wood than the fibrous structure.

The same appearance is common in the sand rocks of the coal region. Now it is not maintained that wood did not exist at the coal period; nor that it was not entombed; nor that it was not in certain circumstances *carbonised* or charred. Such processes still go on, and from *various* causes. In *some resinous woods*, a bituminous principle being present in the tree or plant, would either remain or be given out. But we look upon these facts as mere incidents which occurred then and occur now and always will occur, while timber grows and is subject to chemical action by acids, heat or pressure. And deny that these are great causes put in operation to build up this geological edifice, the earth.

There does not appear to be any reason why the coal plants should congregate in greater quantities in the vertical space of a few feet occupied by a coal bed than in the same space in the shale above. In fact the shale generally seems to contain as many of them as could be piled together in the same space. And by observation these stems are generally confined to the shale and other rocks, being almost entirely wanting in the coal. The argument then, by the evidence, is that the shales are of vegetable origin, and that coal is derived from some other source.

Supply of Vegetable Matter.

And passing by this objection where shall an adequate supply of woody fibre be sought for. The imagination having no bounds to its creation, has constructed a forest of gigantic growth where towering trunks crowd against each other for want of space. Let us dismiss fancy and resort to facts. We can compare the ancient productions with that of our recent western forests.

How much more timber *could grow* at the same time upon the same surface than we now observe? To the utmost it could not exceed double the crop of the bottom lands of the west. What kind of timber was it? No fossil trunk has been found exceeding 60 feet in height. The diameters of the sigillaria, though flattened, and consequently extended in width, seldom exceed two feet. Were these trees more solid, did they contain more bituminous or carbonaceous matter than the oaks, hickorys, and elms of our forests. In general, plants of the quickest growth contain more of the watery and less of the fibrous material. The ancient growth, being tropical, must have been rapid.

But aside from any mere deduction, the impressions left to us, showing the space occupied by a trunk of a size equal to a large tree of our times, are conclusive to every observer that they were either hollow or soft, spongy and succulent plants. Stems having a diameter of 1 to 4 inches become a mere plate, like glass. Lepidodendra a foot through are compressed into the space of an inch and less.

Sigillaria which when found erect are round, and have the appearance of a sturdy tree, when bent down or found prostrate beneath the weight of shale, present a mere scale of matter between the opposite bark. When the limbs or bodies of coal plants are found in a vertical posture their form is often round and apparently perfect. Is this body transformed to coal? Very seldom indeed. Its bark is commonly represented by a coating of coal; but the body, by the shale or sandstone which surrounds it. Sometimes, especially with stigmaria and lepidodendra,where branches pass upward from one stratum to another, the stem is engorged with the material of the lower stratum for some distance above its surface. This indicates a want of solidity of the parts or hollowness which allowed the immediate injection of earthy matter. Many other facts might be added to prove that the ancient tropical ferns of the coal period were even less capable of furnishing carbonaceous matter than our modern plants or trees. The amount which the latter could have supplied, will be shown hereafter. But was it not derived from the bark?—or from the bodies of thin and succulent plants not containing wood? If from the bark alone, how was it separated from the bodies? Where are the naked trunks that produced it? And if it is matter of astonishment how the soil of those times could produce sufficient vegetation for a supply on the supposition that *every part* was worked into coal, in what regions shall we seek for that incredible fertility which could furnish a sufficient quantity when only an hundredth part of the vegetable is converted? When we find a stratum of iron ore, or of limestone, shale or any other rock of the secondary class, and are told that its materials were brought from some distance, there is nothing very strange in the proposition, for we know that vast quantities of these materials *do exist* in various portions of the earth. The question of an adequate supply is in these cases easily settled. But if the limestone or the iron are ascribed to a foreign source, not mineral, to substances not found in the earth, nor naturally belonging to it, it is incumbent on those who advance such an idea to account for the quantity of this foreign matter. Therefore an enquiry into the *sufficiency of the supply* is a material one.

Amount of Vegetation.

The backwoodsman knows that the heaviest growth of the western forest, with all its leaves and brush, would not bridge over the ground on which it stands, with a layer of compact timber ½ foot in thickness. This reduced to charcoal will diminish in weight about 80 per cent. In this process the carbonaceous portions are retained, showing that this timber would, if converted into coal on the spot, make but a very thin plate, not exceeding an inch in thickness. The weight of coal, is from *two* to *five* tenths greater than water; that of timber *one third* to *one half* less. After the watery and volatile portions are driven off, the weight of the carbon and the salts is about 20 per cent. of the timber from which it came. A bed of coal, 4 feet thick, would require, on the supposition that the ancient vegetation was double the strength of the modern, and the vegetables grew upon the same ground, 24 successive crops to complete the stratum. And this, without furnishing any thing but the carbon, and not the bitumen. From very few modern trees, can that substance be obtained, in quantity.—Twenty successive beds of the thickness of four feet, would therefore call for 480 times the timber which can grow upon the soil, at any one time. The evidence in proof of transportation from abroad, as well as reason and analogy, is adverse to such a conclusion. If the growth was contemporaneous with the deposite, it must have taken place upon higher land. How could it be reached by the waters? If reached how could vegetation continue. Brought from a great distance, how could the most delicate fibres, of a tender leaf, have been preserved as we find them? Not an occasional instance, but almost universally. And the minute workings on the exterior of the coal stems, is it possible that these should have survived, in all the perfection of original growth?—If the currents were rapid, certainly not; if they were moderate, the whole must have perished by exposure, during a journey of many hundred miles, or at least the leaves, bark, and softer portions.

In the great coal-field, lying at the western base of the Alleghanies, the northern and southern axis exceeds 500, and the other 150 miles in length. And suppose instead of 20 strata there was but one—each

[illegible] in preceding the 1 a
[illegible] of the inadequacy of the c
[illegible] coral islands. Or the

square mile demands the product of 24, or for one bed of this basin more than 1,000,000 of miles—a space greater than the valley of the Mississippi, from which this growth is to be gathered in.

In a broad sea, what shall create a current from all sides to the center? What mysterious agent would guide the floating mass to every part of the field, in equal quantities, forming beds of equal thickness, carry it to the bottom in regular, and compact order, free of the sediment of those waters; and in the next moment clothe it with a heavy mass of the same sediment?

Transportation of Timber.

The Red River has its rafts, extending many miles in length, which float upon the water. The timber is detained by the narrowness of the stream, its upper portions decay, and its lower sink piece meal to the bottom.

The Missouri and Mississippi, broader and more powerful streams, bear their floodwood in solitary trees to the ocean. Sometimes it descends to the bottom, or is thrown upon the shore, and covered with mud. Here are the prominent cases known to us; the very cases cited by geologists to sustain their position, furnishing nothing analogous to the process required in the formation of coal. Here we have the timber and the currents of water, the sediment to shut out the atmosphere and set the chemical agents at work. The timber sinks in a confused mass, the interstices are filled up with mud; and instead of carbonisation, there is either rottenness and destruction, or thus embalmed they are preserved in kind. But waiving all other objections to the supply, transportation and deposite of timber, the fact of internal lamination in coal, is wholly incompatible with this doctrine.—

Analogy of Peat.

Peat bogs have been called in to aid, in the manufacture of bituminous coal. No *stratified* beds have been found, supposed to proceed from this source, for peat itself does not exist in strata; but carbonaceous matter, allied to coal, has been observed; and trunks of resinous trees surrounded by it, have become carbonised. From this the inference is taken, that coal *might* have been formed under these circumstances. Now although it is something of an argument, that a thing *might* be and not outrage any law of the universe; it is a much stronger one that it *could not* be unless such a violation has taken place. Peat bogs do not, and cannot flourish under water. They are the product of vegetation in the northern latitudes; the result of cold, and not of heat. The coal plants are all tropical. Peat is mere alluvion, and recent; never having been found in quantity embraced in rocks; it is an irregular, limited, and accidental deposite, having in form, composition and geological relation, about the resemblance to the coal strata, that concretionary lime or calcareous tufa, has to the great limestone formation.

Transformation of Wood into Coal.

Surturbrand, Lignite, Bovey coal, and the beds near Munden, are other instances, brought forward to prove that it was from real trees that the coal beds of the earth were derived. Here it is said that the forms of timber exist and are well preserved. It is, I believe, from these beds, that Mr. Parkison selected his specimens, exhibiting the fibrous structure; an experiment which appears to have satisfied mankind of the fact that all coal has the same woody representations. These, however, belong to the recent formations above the coal bearing rocks; the tertiary diluviun and alluviun. They are only found in limited heaps, scattered here and there like the peat bogs just noticed, and are not real coals.

At length Mr. Hutton has made a microscopic examination of the New Castle coal, and testifies to the fact of an arrangement, resembling the vegetable structure, with distorted pores or tubes, filled with a more volatile bitumen, than that of the body of the coal. I have before remarked that it is quite singular that *no more* vegetable fossils are found in the coal strata, and in the limestone strata of the coal formations. If they did not grow upon the spot, but were brought from abroad, it would be incredible that these strata should not have enclosed many of them. If the productions of the immediate vicinity, their absence at the period of the formation of each particular stratum, may be accounted for by supposing a cessation of growth, or an unfavorable influence upon vegetation, by the material there held in solution.—The impression of plants and trunks of trees, is what we should expect to find in all the strata of that period; the coal as well as the sandstone.

Upon the theory of mineral deposition, there *should be* at least an occasional fossil, and such we find to be the case; but not in so grea profusion, as to warrant the inference, that the mass was composed o them. The limestones of the coal region, often exhibit the same scarcity. Why, then, should the presence of a fossil tree, with its bark fibres, rays and concentric layers, *of itself alone*, furnish any mor proof that such was its origin,than it does of the same fact in the sandstone? Was that rock ever thought to be a vegetable product on tha account? Is the shale, in which the growth of that period is deposi ed, *for that reason* attributed to such an origin? All the evidenc arising from the mere presence of plants, applies to the shales wit multiplied force. It has also been observed by geologists, that th shale immediately above a coal bed, is much more bountifully supplie with trunks and plants than any where else; lying in immediate con tact with each other; crossed and intermingled, in a thousand directions. The weight of authority is in favor of a vegetation upon o near the spot where they now lie; and the consequence drawn from their existence, by the authors, is, that this surplus of the ancien herbage, was not mineralised. It appears however to be a fully mineralised here as elsewhere, and to have grown a profusely as it is possible for it to vegetate with success; to hav been buried under the conditions required to form coal; and yet thi compound is not produced. We find only the bark and leaves so converted; the trunks represented by shale, and the interstices, as we should naturally expect, occupied by the same rock. Now may it not be supposed, with more reason, that the coal being already deposited presented to the plants of the succeeding stratum, a new stimulus prompting them to a rapid growth. That each stratum has its peculiar botany is well known. The fire clay beneath the coal seldom has any thing but the stigmaria, and always a plenty of that. This plant is a heavy *marine* vegetable and not belonging to the land. It is not even supposed to have been fixed, but grew floating from place to place. What footing is there for terrestrial plants while the stigmarian stratum or fire clay is in formation. The aluminous and silicious shales, overlaying the coal, have their flora much more abundant and various than the solid sand-rock, because a more moderate and quiet deposition favored such a result.

Composition of Wood and Coal.

But admitting that all coal strata, will on examination exhibit the marks of woody structure, branches and leaves; if from this fact, (should it prove to be one) we step to the conclusion that these trees, and vascular plants, contained *either the quantity or the kind* of the elements which remain, we shall be in error. Unless the body of each individual tree or plant contained within itself the ingredients of coal, the deficiency must come from some other tree, or source. Derived in this manner, there must be a decomposition, in order to receive the foreign ingredient. And if the woody fibre, contains substances *not in the coal*, a like process must have been passed through, in order to allow them to escape. Such a transformation, would imply a chemical dissolution and recomposition; and this would certainly destroy the texture of the wood, though the form might be preserved. If it shall be affirmed, that the parts not destroyed, are filled by the results of those that are, we are forced to adopt the conclusion, that under the effect of the same agents, acting together, upon the same substance, only a part yielded to the forces applied, and a part did not. the consequence of this would be that the portions not overcome would retain not only their original form, but also their *nature*, unchanged.

An analysis of Five English coals, gives:		Three others give:	
Carbon,	72,23	Carbon,	77,53
Hydrogen,	9,44	Hydrogen,	3,76
Nitrogen,	9,79	Oxygen,	17,24
Oxygen,	10,26	No Nitrogen.	

Three of the Ohio coals, give the following results:

Carbon,	47,745
Bitumen,	40,004

Four specimens from George's Creek, Maryland, gave:

Carbon,	81,37
Bitumen,	18,37

Mr. Turner, in his work on Chemistry, considers Naptha, Petroleum, Mineral Tar, and other liquid Bitumens, as composed essentially of the same materials. According to Dr. Ure, Naptha contains:

Carbon,	83,04
Hydrogen,	12,81
Oxygen,	4,65
Nitrogen,	None.

On the supposition, in the absence of analyses, that the bitumen of the Ohio and Maryland coals is similar to naptha, we shall have for Ohio—Carbon, 80,945; George's Creek—Carbon, 96,66. No vegetable can furnish within itself this amount of carbon. Even pure fibre gives for carbon but 51,43. Mr. Liebig (Organic Chemistry) and Mr. Buckland, suppose a part of this given off in connexion with the Oxygen. The fibre is only a part of the woody structure. So we have only 15 to 20 per cent. of the mass of the tree, in the form of carbon.

Fibre contains, in addition to the 51,43 of carbon, hydrogen 5,82; *oxygen* 42,73. The volatile parts of wood, form acids and gums.

The gummy and resinous portions of most vegetables form only a minute proportion of this 80 per cent. of volatile matter.

Take the most favorable known case, the resinous pines, or other conifera, which produce tar by distillation; and compare the proceeds with the bulk from which it is drawn. The pine, however, is not found in connexion with coal, nor is there sufficient evidence to show that other resinous trees were present.

Supply of Carbon.

From whence, then, is the carbon of bituminous and anthracite coals to be obtained? From the animal world?—or from the mineral?—Should it be found necessary to resort to the latter kingdom for any part of the supply, all necessity for the assistance of the vegetable is done away. For the theory takes its existence and force from a supposed want of bitumen in the original structure of the earth.

Earthy Residue of Wood and Coal.

Again, where are the earthy constituents of wood which should remain in the coal? In the report of the re-survey of Massachusetts, it is said: "When we look at the analysis of vegetables, we find these inorganic principles constant constituents, viz: silica lime, magnesia, oxide of iron, potash, soda. Hence these will be found constituents of all soils." In the supposed change which vegetables undergo in the process of carbonisation, is the disorganisation less complete than in the decay of timber and leaves which enter into the composition of soils? Coal contains neither lime, potash, magnesia, or soda. Five western soils gave by analysis:

Sulphate of Lime, - - 2,32
Phosphate " - - - 0,66
Four of these, Carbonate " - - - 2,22—go to the resinous trees. The ashes of the ***Pinusabres*** contain *three* per cent. of *Phosphate of Lime*; and even the pollen of the same tree, has the same per centage. The average phosphate of the ***Birch***, ***Basswood***, (or Linn) and *oak* is 4,83 per cent. All vegetation seems to imbibe the earths and salts, which are given back to the soils by their decay. Such a result is inevitable. The material not being destructible, even by passing through the fire, which reduces the fibre to ashes, nor volatile like a gas, necessarily remains with the residue; and if it ever entered the plant would still have been found in its remains.

In morphia, sweet almond oil, and a few other *artificial vegetable extracts*, nitrogen has been found. In the two compounds just named, 5,53 per cent. (according to Dumas) but with *none*, according to Dr Thompson. Indigo and Cinchonia, have 9 to 12 per cent.

Supply of Nitrogen, &c.

From whence is the nitrogen of the five English coals derived?—If the gums and resins, are analogous to the bitumen, which it is claimed is produced from them, they cannot furnish it. The woody fibre cannot; and the mineral world is present with bountiful supplies' Here it exists, and forms its combinations; why not enter into coal? So with the carbon and hydrogen. All the materials have a being in a mineral state; are placed in contact under circumstances favorable to obey their chemical affinities; whence therefore arises the necessity for crowding aside a simple, consistent and natural explanation to introduce another, which is marvellous and inconsistent. Probably no theory will *completely explain every thing* which is seen in connexion with the coal beds. There are some phenomena in every rock, which perplex the geologist. The true philosophy is to adopt the fullest and most rational theory or none at all. It is not the duty of a geologist to speculate upon the creation, and account for every strange appearance he may discover. He is not bound to do this. It may be considered an accomplishment, and a subject worthy of study, but he has high practical functions to fulfill, dealing rather with the mineral properties, the economical value of the rocks, as they exist, than wit the manner of their existence. My object is to offer reasons wh the coal strata, should not be separated from the coal bearing rocks in the method of their creation; not to account for all the observe phenomena, connected with them. I have referred the coal to a mineral origin; because geologists refer the adjacent rocks to that system By it most, if not all, of the attending facts may be accounted for perhaps as many as of any other rock; but this is a separate discussion, for which there is not room here. And by it we are not driven to imagination, upon imagination, in order to make out a case. W escape the inconsistency of supposing that the vegetation of the surface of the globe became necessary to the upbuilding of its mass.— The incredible fancy, that the unfinished earth destined for vegetatio should in this stage of its creation produce a growth inconceivab heavier than it now does; in its perfect state.

That this precipitate verdure should, while occupying the valley and hill sides of that day, be gathered in from the wide spread region around, and consigned to the bottom of a sea, in a separate mass.— The withdrawal of that sea, to allow farther vegetation, its return harvest and bring it home, repeated many times.

These arguments may not be regarded as conclusive, but appear me worthy of consideration. Geology is not in its nature a scien capable of exact demonstration in many important points. It m be presumptive to question a doctrine as old as the science itself.— But errors have been maintained for a longer period than this, in every department of knowledge. The doctrine was adopted when but a very small proportion of the coal regions of the earth were known; by men who based their opinions upon the brown coal of the tertiary system. They may have in this as in other cases adopted a "visionary theory." If it is so, for the credit of the science among mankind at large, it cannot be exposed too soon.

My convictions on the subject are of some years' standing. They are made public with full confidence that the facts falling within my limited observation can be reconciled in no other way. At the same time I cannot say that others more learned, with more extensive resources of information, (and consequently more light) and especially with the opportunity of personal examination in different continents may not be as much at a loss to reconcile what they have seen and known, by the theory here advanced, as I have been by the doctrine of the books.

Stanford University Libraries
3 6105 016 828 084

BRANNER EARTH
SCIENCES LIB.

DATE DUE

STANFORD UNIVERSITY LIBRARIES
STANFORD, CALIFORNIA 94305-6004

GAYLORD